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WEST EUROPE REPORT

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CONTENTS

MATRA ENTERS COMPETITION FOR WORLD ROBOTICS MARKET

Paris L'USINE NOUVELLE in French 9 Jun 83 p 137

[Article by Michel Defaux]

> [Text] With two state-of-the-art products in the field of "peri-robotics," Matra and its subsidiaries are taking the plunge into world-class competition. A wise decision: these markets are still in the startup phase, and a lot less competitive than the industrial robotics market.

This week brings the opening of the World Machine Tool Exposition at Porte de Versailles. One of the big draws at the Salon is the Matra stand, where the company and its subsidiaries are showing off their combined know-how and expertise in robotics. Judge for yourself! The flexible cell on display includes a computer-assisted design unit from Matra-Datavision and Euclid, which is used to design automobile dashboards. This CAO provides all the positioning data for dashboard dials and components in real time to a Sormel-built Cadratic robot which then performs the actual laser cutting. It uses a 100-W continuous laser from the French Laser Application company, coupled with a fiber optic.

"This is the first time," explains Laser Application's president and general manager, M Prétot," that anybody has worked with fiber optics on an industrial scale."

Key Rôle of the Vision Module

The openings are cut to the precise dimensions of the dashboard components (tachometer,indicators), and then the control unit in the flexible cell, the Matra Syscomat, orders up another robot equipped with three suction-grips, which then finds the proper components, turns them right side up, and inserts them in their custom-cut places. To do this, the robot is assisted by Matra's vision module (Visiomat), which identifies the objects, gives their precise position and their orientation, and makes sure they are all picked up.

This family of vision products, along with the control panels in its flexible cell, form the core around which Matra has planned its debut in robotics.

"These products were all developed from scratch in 6 months," says Jackie Saleur, who is in charge of robotics development. "The market today in the vision area typically features excessively high costs -- usually over 200,000 francs, coupled with mediocre performance. We believe that a real market will be there when the prices for systems level off at around 100,000 francs." The range of Visiomat products usable in video-inspection (control) and video-placement (slaved to a robot) will operate in 256 or 512 points, with binary (black-and-white) images or with 64 tones of grey. It is designed for use with an open-bin array surrounding the robot, and is based on a high-performance hardware module backed by very advanced software.

Some examples: the system has plugged-in operation capacity for such tasks as real-time image removal and contour extraction, developed in collaboration with Laas, and will soon offer automatic adaptation to lighting conditions. The software operates on the standard procedure of statistics on parameters (surfaces, perimeters), but, for additional certainty it is backed up by other methods: relational (constant monitoring of all relations among the objects various contours) and syntactical contour description (which allows for finishing and polishing without damage to corners or projections).

A Product Far Ahead of Its Market

"The performance of a vision system lies in the type of object it can recognize," explains Jackie Saleur; "and there are not many on the market now that can recognize a tachometer." The second product, the control unit for flexible cells, enables the operator to manage a cell without having to go through automatic channels or robot commands.

"Aproduct far ahead of the market," agrees Thierry Pellerin, marketing and development director for the control and automation branch.

What ambitions does Matra have for these two products? When it comes to cell controls, management would rather not say much. It's a relatively strategic product, whose market will take off in parallel with that of robotics. The vision market, though, is more readily identified; it is a relatively young market, and is starting very low (people will quote growth figures running at 200 and 300 percent per year), with a lot of companies in the running. Top among them are American companies (Automatix, Object Recognition System, Machine Intelligence, General Automation) and Japanese firms (Fuji Electric, Hitachi, and Matsushita). With a

relatively high-performance product and a relatively modest price-tag (around 120,000 francs), Matra can make the breakthrough. For these vision products, with delivery promised in 1984, the low sales projections call for 9 million francs in 1984, 28 million in 1985, 55 million in 1986, and 95 million in 1987.

"We're shooting for 10 percent of the world vision market," says Thierry Pellerin, and we expect to be among the top five in the world."

Matra's Place in the Robotics Alignment

The government was hoping for just a few leaders in robotics (CGE, Renault, Matra), but it wanted a sound ancillary network of small and medium companies with the skills and know-how required. There have been talks between Renault and Matra. "These negotiations to strike a harmonious chord have just begin," Thierry Pellerin warns. "They will ensure better coordination in research and development around assembly." Matra and its subsidiaries we handle small assemblies (small motors and pumps), while Renault will handle heavy assembly.

As for small and medium companies, one bit of news is the formation of Midi Robots (50 percent government financed, 20 percent financing partners, and 30 percent from industry sources, including Matra, Renault, and Sesa), which should make it possible to speed up a number of research projects now under way in the Toulouse laboratories (Saas, Cert, Paul Sabatier) and thus bring them up to the industrial application level sooner. "Midi Robots will be operational next September. It is the first of a new breed of small and medium industries."

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CSO: 3698/337

ESA, FRG, FRENCH MICROGRAVITY MATERIALS SCIENCE PROGRAMS

Paris L'AERONAUTIQUE ET L'ASTRONAUTIQUE in French No 2, 1983 pp 15-31

[Article by P. Pesenti: "Status of Microgravity Materials Science"]

[Excerpts] [Summary as published in English] Just as the first flight of Spacelab aboard the Shuttle Challenger scheduled early next October is further delayed, we try to present the situation of the microgravity materials science programmes with particular reference to French experiments which have already yielded encouraging results.

It is now clear that on available spacecraft technical and operational constraints considerably complicate the development and use of the high quality instruments required for the fundamental research to which scientific groups have given priority.

Applied research oriented towards the development of genuine and unique material processes seem even more difficult to promote due to the high cost and relative infrequency of dedicated flights. This kind of experimentation does require repetitive runs for its success.

In spite of all the efforts of scientific laboratories and supporting space agencies in the world, it will take a long time to proceed beyond the exploratory and single-point result stage.

Therefore, we cannot expect the industrial applications of microgravity to be any clearer when are taken major decisions on the development of the large orbital carrying capability contemplated for the end of the century.

However although the results of the present space-based programme are limited, it has a growing impact on research orientations, methods amd instrument techniques for materials science in general and this is a good reason to maintain pressure in this field.

The ESA's Microgravity Research Program

The ESA's [European Space Agency] microgravity research program on the life sciences and materials sciences was officially launched on 15 January 1982[x] within a framework of optional participation by its member countries.

As presently set up, the program is limited to a period of 4 years at a total cost of 37.4 MECU [million European counting unit(s)][1], 72 percent of which is to be covered by the participants[2].

Efforts are to be centered on three principal elements of the program:

--The Biorack: This is a multiple-user experimental installation for carrying out research in the field of cells and of molecular biology, aboard Spacelab. The proposed experiments include studies on plants, insects, the cells of mammals, and bacteria. This equipment is scheduled to fly, for the first time, on Spacelab's German national mission D-1 (mid-1985).

--Fluid Mechanics Module: A multiple-user experimental installation to be part of Spacelab's first mission in 1983 for the study of phenomena relating to the hydrodynamics of liquid floating zones. This initial version of the module needs some revisions to improve its capabilities for meeting new requirements being advanced by the fluid mechanics specialists. The improved version will probably be ready for inclusion in the German D-1 mission.

--Sounding Rocket Experimentation: The Texus sounding rocket experiment undertaken toward the end of the 1970's by the FRG [Federal Republic of Germany] in cooperation with Sweden is acknowledged to have been a brilliant technical success. The ESA has therefore reached an agreement for use of the launching system and available experimental instrumentation, on behalf of the microgravity program's participating member countries as a whole. Research activities will cover essentially the fields of the physics of fluids and of solidification. The budgetary allocation of 7 MECU will enable the ESA to use 50 percent of the capacity of the two annual launches planned during the period of the program.

FRG

The FRG has decided to accord greater importance to the microgravity science, especially materials, program over other space science disciplines. It is spending more in this domain alone than France is for its entire scientific program. The FRG's annual budgets will increase from 54 million DM in 1982 to 80 to 100 million DM over the next few years.

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x) [no reference given].

1) 1 UCE = $1.065 (1982 rate).

2) Germany 27.57 percent; Belgium 4.49 percent; Denmark 2.51 percent; Spain 1 percent; France 15.5 percent; Italy 7.5 percent; Netherlands 5 percent; United Kingdom 1.35 percent; Sweden 4.25 percent; Switzerland 4.06 percent.

While conducting a program of subsidies to experimenters under the heading of laying the groundwork for various high-technology instrumentation programs to come, and having realized and continued to exploit a technically notable program of experimentation with sounding rockets (Texus), the FRG is pursuing a policy of access to the Space Shuttle that in fact makes the FRG the principal partner of the Americans. This policy is illustrated by the D1 program (June 1985), under which the FRG is chartering up to two-thirds of the entire capacity of a Spacelab, at an outlay for integration and flight costs totaling 240 million DM.

ESA

The ESA is responsible for preparing the European portion of Spacelab's first mission, during which 35 experiments are to be carried out, 8 of which are being underwritten by French experimenters. During this mission, the GHF [gradient heat furnace] developed by the CNES [National Space Studies Center] and incorporated into the MEDR [Materiel Science Double Rack [as published]] being furnished by Germany will fly for the first time.

No further scientific program had been provided for under the ESA until the beginning of 1982, when a 3-year program, to be financed by contributions from the member countries, was introduced (see above). This program could undergo more substantial extensions, particularly if development of a retrievable automatic platform (EURECA [European Retrievable Carrier]), to be carried up by the Space Shuttle, is undertaken. This platform could make its first flight in 1987, carrying 3 to 4 large materials-sciences instrument packages.

Second Part

French Program

Participation by the scientific community in the program being subsidized by the CNES is limited to a small number of public and university laboratories. In all, less than 30 persons are involved, more than half of whom are connected with the LES [Solidification Research Laboratory] of the AEC [Atomic Energy Commission] at Grenoble.

Although recognizing the innovative nature of the microgravity sciences (materials and biology) and their potential impact on terrestrial applications, the CNES has not allowed much for these disciplines in its scientific programs subsidies budget, where they represent less than 15 percent of the total for 1983. For that matter, the French experimenters, generally speaking, accord priority to basic research projects in their proposals for funding. The materials science laboratories, none of which belong to industry, are not structured, without solid technical support from the outside, to spatialize their experimental technologies, to say nothing of the complex methods involved in the integration and use of the flight instruments involved.

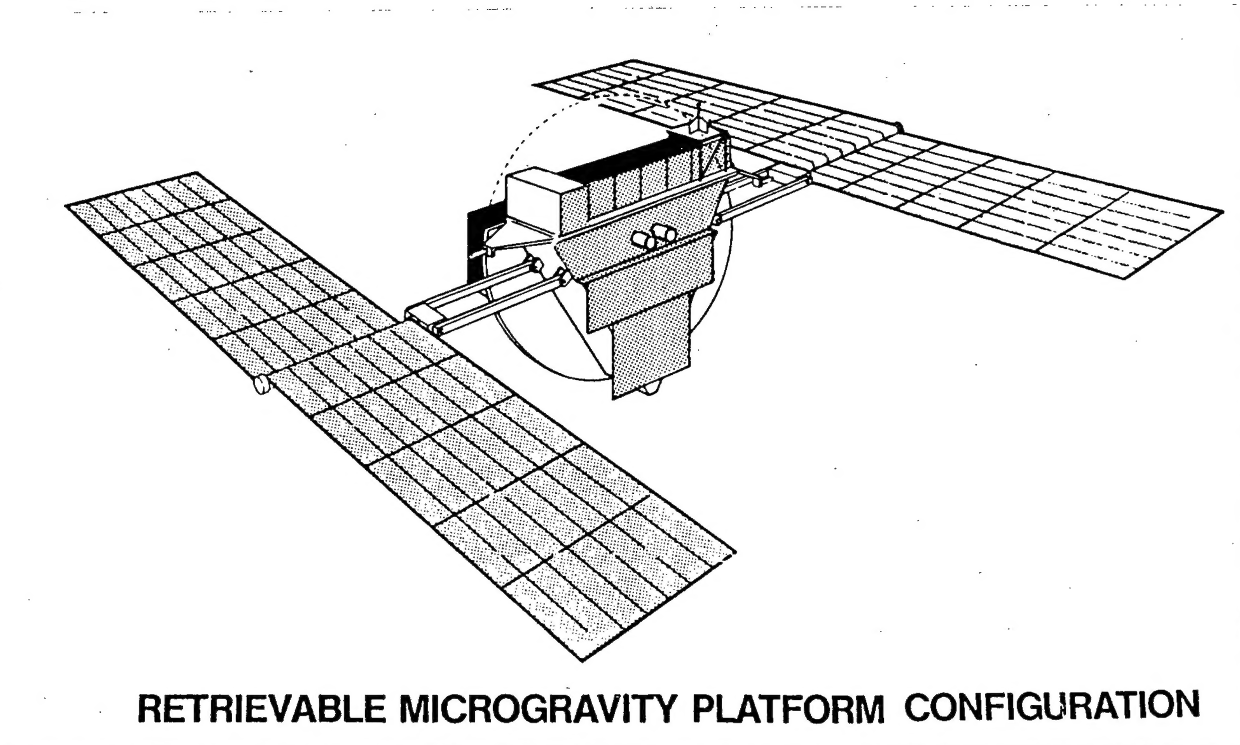


Fig 9 - EURECA [European Retrievable Carrier]: Example of a configuration that has been studied under Phase A by the ESA.

The GERME [Studies and Research Group on Materials in Space][1], a group of 7 or 8 persons, at the CNES's Toulouse Center, provides assistance to laboratories that take on anticipatively the technical work most specifically oriented on space aspects: Designs and development of apparatus, its integration and subsequent use.

The dispersion of the laboratories, which the multidisciplinary cooperative nature of the projects tends to accentuate, as well as the marginal or at least nonexclusive nature of their space activities, are obstacles to the development of a specialized technical competence demanding a concentration of effort among the important teams. This problem also has a financial aspect. Total annual expenditures at the national level--including personnel expenses in the laboratories and the CNES and for the carrying out of experiments strictly speaking--are of the order of 25 million francs, which is a very modest sum in no way comparable to the French contributions toward the development of the large-scale space facilities under the ESA (Spacelab, Eureca) or to the costs their subsequent use will involve.

The top priorities of the French program were reaffirmed at the Arcs Symposium in September 1981. They are:

--Solidification of metallic alloys and miscible and immiscible semiconductors;

--Growth starting from the vapor phase;

--Growth in solution.

Emphasis was placed on the need for quantitative in situ studies of the mechanics of the fluids associated with these different areas of research.

Initial Results of French Experimentation

Joint Franco-Soviet ELMA 1 [expansion unknown] Program

Some 10 canister experiments were carried out during the first half of 1979 in Salyut 6, using Kristali and SPLAV [expansion unknown] furnaces. The principal results can be summarized as follows:

--The experiments on the growth of germanium and vanadium oxide involving their transport in the vapor phase, worked out by the Bordeaux Laboratory of the Chemistry of Solids (Experimenter: J.-C. Launay), were not carried out under the specified conditions. An increase in the size of the crystals was noted, however, as well as a high degree of perfection of their free surfaces, as compared with the same experiments carried out at ground level. Similar results had already been observed during previous experiments in the vapor phase. The TTC [expansion unknown] team (Experimenter: Mrs H. Rodot) worked out a series of experiments on the growing of crystallized materials (indium, antimony, bismuth telluride, tellurium, bismuth) on substrates of small area, making it possible to obtain natural forms without contact with the walls.

Experiments in growing gallium arsenide in Gn [as published] solution and gallium indium phosphide in indium solution, worked out by the same team, yielded a substantial improvement in crystalline quality and an increase in rate of formation. In addition, a sample of gallium arsenide doped with tellurium showed very thin striations (2 to 4 microns). This phenomenon, which is not exhibited by earth-based samples, appears to be linked to dislocations in the growth of the crystal, which would indicate that a process of creation of nonhomogeneity can exist in the absence of convection.

The LES of the AEC in Grenoble (Experimenter: J.-J. Favier) has carried out experiments in solidification aimed at low-tensile alloys (tin plus lead, and aluminum plus copper), to study the destabilized (cellular or dendritic) structures obtained at ground level and in microgravity. These experiments have yielded important findings:

1) The elimination of convections in microgravity increases interfacial destabilization, the result being typical structures of large size;

2) Incorporation of the minor constituent into the solid was achieved without observable segregation, establishing the feasibility of obtaining a pure diffusion process in a stationary mode;

3) Crystalline orientations (faceting) are different at ground level and in microgravity. This is interpreted by the experimenter as being the consequence of the reduction in fluctuations of convective origin in microgravity, permitting the system to develop a thermodynamically more stable morphology. Growth direction 110 corresponds closely to the minimum energy interface plane.

The Louis Neel Laboratory of the CNRS [National Center for Scientific Research] at Grenoble (Experimenter: R. Lemaire) has achieved the solidification of magnetic compounds Nd Co - Ce Mn [neodymium cobalt - cerium manganese]. Only a slight increase in the size of the compound defined as Nd Co_2 was observed by comparison with the expected one. On the other hand, a substantial attenuation of reactions with the envelope material was noted. This goes back to the findings that resulted from prior experiments in solidification regarding the singularity of liquid-wall interface behavior in microgravity.

Experiment in Aluminum Indium Immiscible Alloy Solidification

The first French experiment of this kind was carried by means of a sounding rocket under the American SPAR [Shuttle Payload Assist Rocket] program. The launch in January 1981 was a successful one. The X-ray photographs taken of the space sample show a dispersion of the indium-rich phase. Under the same conditions at ground level, the settling of this phase is clearly visible at the bottom of the crucible. The success of this experiment is owing to the controls over the capillary properties of the phases in the presence of and with respect to the crucible.

Controlled Solidification of Doped Germanium and of Al-Al_2Cu (J.-J. Favier, LES-AEC Grenoble)

This experimental effort is being carried out jointly with the DFVLR [German Research and Experimental Institute for Aeronautics and Astronautics] (FRG). Dr Walter's objective, under the Texus program, is to grow gallium-doped germanium starting from a remelted sample with the aim of obtaining high levels of doping very homogeneously distributed.

Two experiments have already been carried out, in May 1981 and 1982. These have enabled the development of a technique for measuring the instantaneous rate of solidification, which is a function of the interlamellar spacing (radial distribution) in the Al - Al_2Cu eutectic.

They have also enabled verification that sounding-rocket experimentation is a viable method for this type of research. The microsegregation profiles obtained during the last flight showed the complete disappearance of dopant microsegregations in the germanium.

The forthcoming experiments will be carried out in four identical furnaces operating simultaneously (three germanium samples and one ternary Al Al_2 Cu sample).

Experiments Aboard the Flight of the French Cosmonaut

These experiments, carried out between 24 June and 2 July 1982 during the joint Franco-Soviet flight in which J.-L. Chretien took part, included three experiments using 5 heat cycles of the Soviet Magma furnace (see "Materials Science Experiments on the Mission of the French Cosmonaut" below).

The calibration tests provided quantification of the technique of the furnace, completely enveloped by the environment within the capsule. Variations of the order of 50°C were recorded; these are explained both by the cooling effect of convection at ground level and by the differences in external ventilation systems at ground level and in flight.

Onboard residual acceleration levels were measured for the first time, by means of a triaxial accelerometric recorder mounted on the furnace. Recorded values during crew activities (up to 3×10^{-2} g peak to peak) are sufficient to perturb metallurgical experiments. Residual levels while the crew is asleep (1.5 to 5 $\times 10^{-4}$ g), on the other hand, appear to be acceptable.

The data obtained from the experiments on immiscibles in disperse phase and "diffusion" have not yet been completely processed, but some interesting findings have already been made, such as the presence of accumulations of the indium-rich phase at the two extremities of the directionally solidified samples, whose possible relationship, on the one hand to residual accelerations, and on the other hand to nongravitational movements of a convective type (Marangoni), it is being sought to establish.

The diffusion experiment yielded transport coefficient values systematically lower (20-40 percent) than values measured at ground level in comparative experiments, showing that the method of measurement, despite its low sensitivity to currents produced by variations of concentration of the diffusion constituent, is nevertheless affected by them under ground conditions.

Continuation of the Program

The French experimental program will probably be continued during the decade, basing it largely on the Space Shuttle, particularly through our participation in the inter-European program.

The forthcoming stages of experimentation will consist of:

--Eight experiments as part of Spacelab's first European mission;

--Two experiments on vapor-phase growth of HgI_2 [mercuric iodide] aboard Spacelab's second flight dealing with materials, scheduled by NASA for the end of 1984 (SL3).

--Five to seven experiments to be carried out in the French gradient furnace, which is to be carried aboard flight D1 organized by the FRG for mid-1985. These experiments are concerned with solidification, vapor-phase growth, and the Soret effect.

The outlook beyond 1985 is for more extensive and, it is hoped, more regularly scheduled flight availabilities to enable a departure from the present case-by-case stage of experimentation and the launching of scientifically more ambitious programs along less precarious executory lines.

The French program will take advantage of bilateral cooperation not involving exchanges of funds, and offering it the possibilities of repetitive flights at no charge, to carry out systematic experimentation under its priority headings. The success of this policy will depend on the fulfilling of two conditions:

1. A consolidation of the participating scientific community from the standpoints of extending scientific contributions to a larger number of laboratories and of unlocking the doors on existing activities that are frequently confined to the inner sanctums of the laboratories engaged in them.

2. Development of embarkable instrument packages that are specific to the research to be undertaken and optimized for the experiment to be performed.

As regards the first condition, the problem is that of the credibility of the programs being proposed by our scientific community in the eyes of our partners, which depends not only on the intrinsic value of the theses involved but also on the size of the contribution and the number of researchers actually committed to them over a sufficiently long period of time.

Improvement of our scientific "critical mass," in terms of staffing, is indispensable to these programs, including our being able to hold our position with respect to the rights of participation open to us by virtue of French contributions to the ESA.

An effort will therefore be made to mobilize more of the scientific community in the near term, by stimulating research in earth-based laboratories through specific programs such as the "Materials and Microgravity Program," which is designed to encourage research under the following headings:

--Experimental studies and modelization of the dynamics of fluids in crystal-growing media and consequently subjected to variable convective and diffusion systems, depending on configurations and gravity. A major effort is to be made to develop in-situ measurement techniques, at least in transparent situations (interferometric holography, laser velocimetry, etc).

--Research on phenomena at liquid-gas, liquid-solid and liquid-liquid interfaces, particularly during phase changes toward the solid state;

--Research on improving terrestrial processing methods based on an understanding of couplings between transportation and growing processes. As regards the second condition, the CNES has undertaken or will be undertaking research, jointly with the laboratories, on custom-designed experimentation packages whose emplacement aboard the vehicle concerned can be negotiated well in advance with agencies that are open to cooperation (NASA, Intercosmos). The putting aboard of these equipments will be done under agreements covering the execution of a joint experimentation program.

With this in mind, the CNES has under way in the predevelopmental stages three instrument packages as follows:

1. Basic Research on Controlled Solidification

Controlled solidification of alloys has been one of the principal subjects of research at the AEC Grenoble Center's LES. The latter is therefore proposing the development of a custom-designed package designated Mephisto (Fig II-2).

The overall objective of the research to be based on this setup is to develop models of the behavior of a system in evolution under the action of perfectly calibrated external parameters (temperature, temperature gradient, rate of displacement) over a broad range of values.

In the terrestrial environment, convections of thermal and solutal origin, which are difficult to control, introduce redistributions that are difficult to calculate, and compositional and thermal fluctuations, moreover, cause irregularities of growth.

In microgravity, the liquid phase being no longer subjected to convections but to diffusion in a calm liquid, its composition is calculable as a function of the thermal field. Unperturbed conditions are therefore available for the study of the subtle phenomena occurring at the growth interface.

It will be possible to create chemical and kinetic conditions of instability at the interface as a function of the parameters external to the experiment, study their thresholds, and bring forth their typical structures. It will also be possible to create perturbations in growth by controlled variations of these external parameters.

A maximum of data will have to be gathered concerning the system's in situ behavior. This is why different techniques for performing difficult measurements are to be associated with the Mephisto instrumentation package (see "The Mephisto Project").

The setup incorporates samples that are unreplenishable in flight and that are processed in accordance with an entirely automatic procedure. The setup is thus suited for orbital experimentation of short duration and is therefore designed to be mounted in self-contained structures to be carried in the hold of the Space Shuttle on transport flights involving a few tens of hours of microgravity.

2. Processing of Monocrystals in the Vapor Phase

This is a project of applications nature involving a growth process termed "trizonal" that was developed by the Experimenter Laboratory for use at ground level as well as in microgravity.

This process, on which the "Multizone" project is based (Fig IV-1), consists of setting up a forced flow between the two ends of a growth enclosure, then creating, by means of an intermediate gradient, a controlled local supersaturation that sustains in a stable manner the growth of a monocrystal.

Developed for the physical transportation of the HgI_2, which takes place at low pressure, this process should be of only marginal interest in microgravity, since it theoretically eliminates the convective return of the vapor phase. However:

--The presence of recyclable gaseous impurities in the flow can trigger the onset of convective currents which, in microgravity, will be replaced by a gaseous screen through which the active gas will diffuse;

--Gravity is a factor in the axial dissymmetry of flow in the horizontal position; this is verified by the localization of the germinations, which is always downward;

--The nature of the gasodynamic system can influence the deposited composition if the material contains many volatile elements (for example, PbSnTe), and the more so if evaporation is not congruent and the masses of the gaseous elements are different.

Physical transportation in microgravity can thus hold favorable surprises for materials that are sensitive to the composition of vapor and to the configuration of flow.

On the other hand, use of this method in microgravity is of considerable interest where high pressures (of atmospheric order) are involved. This is precisely the case of processes involving a chemical reaction, wherein a recombination flow opposes an inverse decompositional flow (for example, the Ge-Ge I_4 system under study at the Bordeaux Chemistry of Solids Laboratory). Under ground conditions, these flows tend preferentially to organize as convective currents. In microgravity, exchanges by pure interdiffusion are relied on to produce homogeneous sectional concentrations, thus favoring a better organization of concentrations around the growing crystal.

Applications experimentation will therefore be centered on the choice of growth materials that cannot be produced under terrestrial conditions by the other methods and which, with regard to the vapor phase method, exhibit insufficiencies induced by convective-type gasodynamic systems. A number of these materials are currently in the process of being selected. The space setup can be developed in two versions: One, a replenishable version (for manned flight); the other, a multiple-furnace nonreplenishable version (for unmanned flight).

3. Processing by Zone Fusion

The FRG's program has made of the radiation heated zoned furnace one of its distinguishing options. Having developed, to begin with, a bi-ellipsoidal reflector furnace for the FSLP [expansion unknown], it is now developing for program D_1 a higher-performance mono-ellipsoidal furnace involving a quartz cavity surrounding the sample, isolating the latter from the mirrors. A similar furnace is proposed in an automatically replenishable version for the EURECA.

Floating-zone (contactless) processing in microgravity is being reckoned on, since the possibility of a melted zone of large size and regular cylindrical geometry translates into excellent thermal stability and large gradients in a liquid state not subjected to convections. These performance characteristics would permit the processing of highly doped, homogeneous (free of striations) mono-crystals.

The Marangoni convections generated in the liquid mass by variations of surface tension with temperature, and which are therefore independent of gravity, unfortunately hinder the perfection being sought. A major effort is being deployed in the FRG and the United States as well to study these parasitic effects at ground level and to try to control them, especially through manipulation of the value of the surface tension coefficients by modifying the general composition of the liquid and/or by introducing an insoluble film of suitable properties over the surface.

Interest in the potential for floating-zone processing in microgravity, although reaffirmed by the increasing scope of German projects, has not yet had the benefit of direct experimentation. The CNES is therefore encouraging French laboratories to develop their own experiment in this domain, so as to be in a position to take advantage, within a few years, of the facilities the EURECA will make available for use by the Europeans.

The Minizone project, aimed at rapidly bringing an experiment within reach of French users, is designed to facilitate largely qualitative exploratory studies on the zone behavior and properties of various compounds, particularly those that are reactive with crucibles. The small size of the zone will facilitate ground versus space comparisons with due regard for geometry. Installation and operation aboard an occupied vehicle will be easy and planning can be based on stepped-up numbers of experiments.

Conclusion

The now regularized use of the American Space Shuttle appears to have opened up experimentation in orbital microgravity for the carrying out of the research programs in materials sciences contemplated by the Americans and Europeans.

This seemingly high capacity for carrying instrumentation can be delusive, if what is to be undertaken is no longer "pioneering" experimentation--intended to yield only indicative results pointing to avenues to be explored in greater depth--but rather the systematic carrying out of basic and applied research efforts of essential scope.

The orbital space facilities being planned, with no prospect of their being able to evolve rapidly over the next 10 to 15 years, are ill suited to the experimentation on a sufficiently repetitive basis that is demanded by this science at the present stage of advancement of its methods.

Its objectives must therefore be viewed as priced at the upper reaches of the cost scale, while the technologies and methodologies used must yield the highest possible experimental returns:

--Experimentation of the basic type must make use of high-performance setups for the quantification of the phenomena being studied;

--Applications experimentation must be based on the use of means specific to the process being implemented, to enable attainment of the highest possible degree of optimization with regard to performance factors and control of parameters.

From this standpoint, the scientific instrumentation to be developed must match, in number and diversification, the different objectives and technologies that are irreconcilable in a single package capable also of satisfying the constraints of orbital space.

It is incumbent on the experimenters to develop methods of preparing experiments on the ground that will ensure complete optimization of the experiment in microgravity at the first go, by coupling experimental studies on the ground with theoretical work, and physical simulations with computations. They must also be capable of analyzing the results of their experiments with exceptional care and exactitude.

Although the efforts necessary to raise research in microgravity to its required level of maturity are making themselves more and more evident to the experimenters and government bodies, it is not at all certain that any effort is being made to pay their price, particularly where it can yield the most returns in terms of reducing the high risks of failure and of insufficiency of experimental research programs over the next several years.

By their very nature, the organizations responsible for space programs are tending to place higher priorities on the development of hauling technologies and space-based services. It is more difficult for them to intervene upstream with respect to research itself, its objectives and methods, with a view to adapting it to space.

This situation has an encouraging counterpart, however. It is the broad openness to international cooperation on the part of the nations having the all-important space-flight facilities, of which the laboratories engaged in experimentation are able to make good use. Nevertheless, if some really substantial manufacturing technologies were to make their appearance, this state of mind would change: Scientific exchange would find its limit in the preservation of the commercial and strategic monopolies, to the benefit of the possessors of the major carrier systems.

[Boxed inserts pp 25, 28, 29 and 30 follow]:

Materials Science Experiments on the Mission of the French Cosmonaut, p 25

The equipment included a Soviet gradient-heat shuttle furnace and its automatic control system electronics, in association with the following French equipment:

--Triaxial accelerometric platform (resolution 10^{-5} g);

--6 thermocouple measuring devices located at various points of the furnace;

--5 experimental canisters equipped with 9 thermocouples;

--An electronic system for acquisition, sampling and digitizing of data from the accelerometric channels and thermocouple measurements;

--A cassette recorder.

The experiment program was carried out by V. Ivantchenkov, crewmate of J.-L. Chretien. It consisted of:

1. Two experiments labeled "Calibration" of the furnace:

These were designed to determine the laws governing the thermal behavior of the oven and of the canisters in microgravity and in the terrestrial environment. These laws are different, since the thermal exchanges take place in

the ambient air, with participation of convection in the terrestrial environment. Two thermal cycles were carried out on two types of canisters simulating one of the real experiments.

2. One diffusion experiment (Experimenter: N. Eustatopoulos, INP [National Polytechnic Institute], Grenoble):

The object of this experiment was to determine the value of diffusion not affected by solutal convections or decantation between Cu and Pb.

The method chosen consists of measuring the rate of deepening of a cleft formed at the line of emergence of a grain boundary of a metal A (copper) in a liquid B (lead saturated with the copper).

The creation of this cleft, whose dihedral angle Ø (see Fig 1-1) satisfies the condition of equilibrium between the boundary potential and the solid-liquid interface potential (wherein $\sigma_{SS} = 2\sigma_{SL} \cos \frac{\varnothing}{2}$), leads to the formation of curvilinear interfaces that give rise to a chemical potential gradient.

Under the influence of this gradient, a transfer of material takes place through the liquid phase, from the root of the cleft toward the adjacent planar interface, producing a continuous variation of the linear dimensions X of the cleft (X = d, w, h) as a function of time t, in accordance with the following law:

$$X = L\,(T)\,(D_{A(B)} \cdot t)^{1/3} \quad \text{at } T = \text{constant.}$$

In this relation, for a given metallic pair, L(T) is a function solely of temperature, and $D_{A(B)}$ is the interdiffusion coefficient of A in liquid B.

From this, it can be seen that the simple measurement of the linear dimensions of the clefts in two samples maintained at constant temperature, one at 0 g (X^o), the other at terrestrial gravity (X^s), all other conditions being identical, provides a direct evaluation of the relation:

$$\frac{D^o A\ (B)}{D^s A\ (B)} = \frac{X^o}{X^s}\ 3 .$$

The experimental canister contains 12 diffusion cells divided into four capsules that are subjected to four temperature levels for a period of 8 hours.

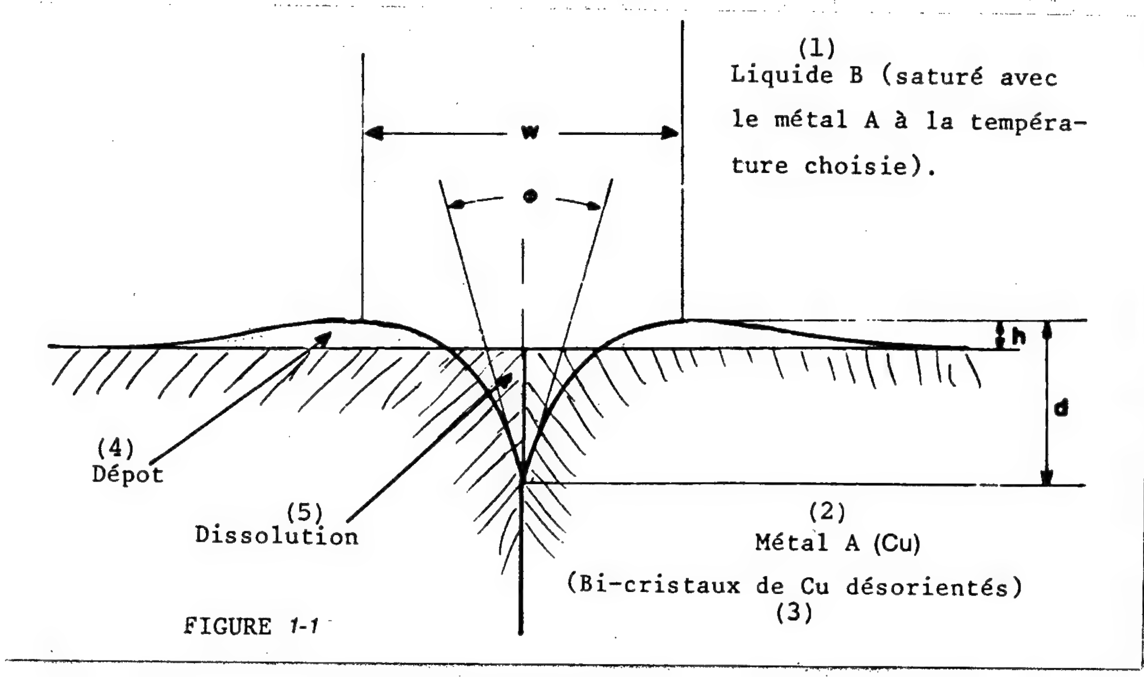


Fig 1-1.

Key:

1. Liquid B (saturated with metal A at the chosen temperature).
2. Metal A (copper).
3. Dislocated copper bi-crystals.
4. Deposit.
5. Dissolution.

3. Two Aluminum-Indium Immiscible Alloy Processing Experiments (Experimenter: C. Potard, LES, AEC Grenoble):

These experiments were followups and extensions of the sounding-rocket experiments. This time, they involved slow controlled solidification, in the furnace, of a compound raised to a temperature lower than total miscibility, to study:

--The liquid phase coalescence that takes place in the principal aluminum liquid phase;

--The interaction of this second phase (In) with the principal monotechnical phase during solidification of the emulsion.

The Mephisto Project [p 28]

This instrumentation project is being studied by the LES of the AEC Grenoble in cooperation with the CNES. It is designed to contribute to basic research on controlled solidification of metallic alloys. Followup research on compounds of applicational interest is not to be excluded.

It involves three samples in cylindrical capsules of long length incorporating a controlled liquid zone between two equal gradients (G from 10 to $400^{o}C/cm$), one of which is fixed and the other moving (at a rate of from 5×10^{-5} to 5×10^{-2} cm/sec).

The presence of these three identical samples will make it possible to obtain several types of measurements simultaneously:

--True temperature at the solid-liquid interface by measurement of the Seebeck (thermoelectric) effect developed by the two phases;

--Instantaneous speed of the moving interface by plotting of the Peltier pulse;

--Temperature gradients.

The following studies will be undertaken:

--Distribution (macro-segregation);

--Chemical and kinetic instability thresholds;

--Perturbation of growth effected by variation of external parameters;

--Relations between the structures obtained and the growth systems.

This project is being drawn up as part of a joint undertaking with the United States, with a view to its utilization in flight beginning in 1987.

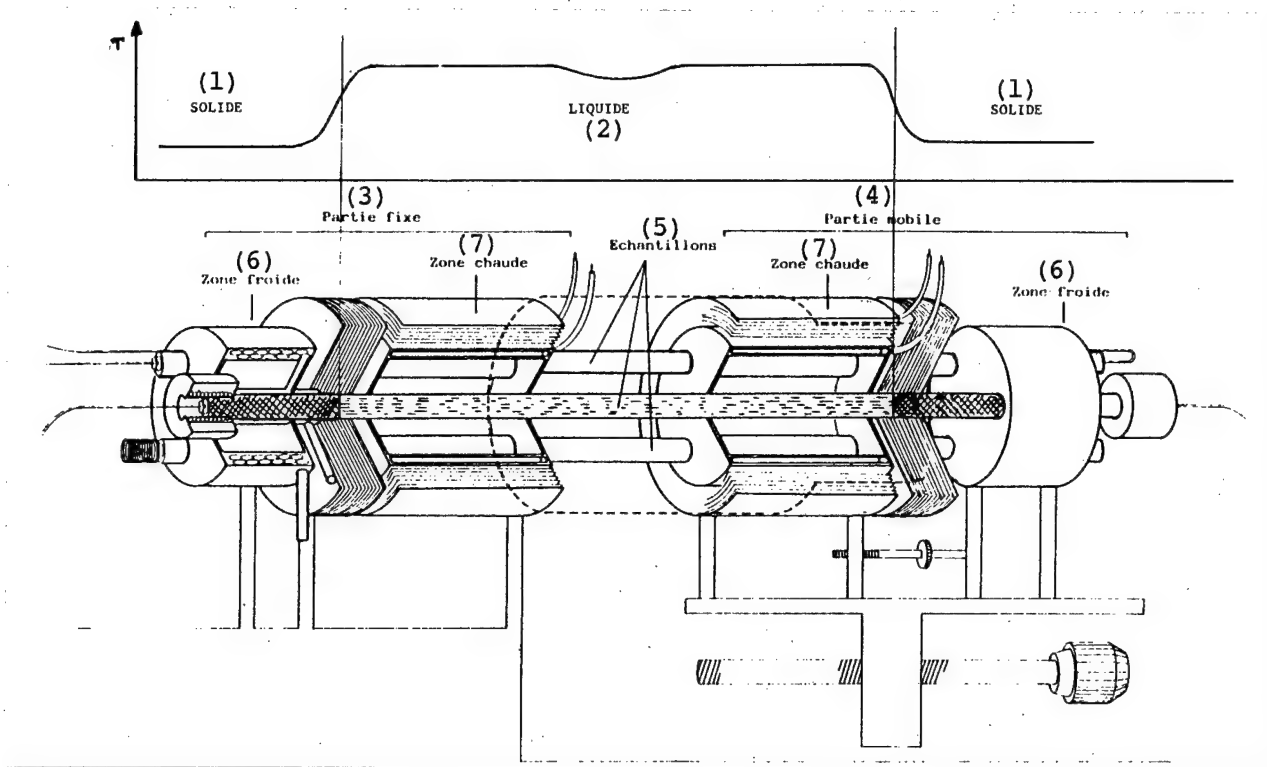


Fig II-2 - Mephisto instrumentation package.

Key:

1. Solid.
2. Liquid.
3. Fixed part.
4. Moving part.
5. Samples.
6. Cold zone.
7. Hot zone.

Multizone Project

Based on work done by several French laboratories, particularly at the University of Sciences at Clermont-Ferrand, a method of controlled-flow vapor-phase growth was proposed for experimentation using various models and systems in the terrestrial and microgravity environments.

The growth setup (see below) involves three isothermal zones of adjustable temperatures, separated by localized gradients. At the two extremes are the source (S) and the sink (P). The temperature difference $T_S - T_P$ establishes a forced flow of material owing to the difference of equilibrium pressures. The temperature of the central deposit zone T_d establishes a local supersaturation at gradient $T_s - T_d$ which determines at the start of the experiment the frequency of nucleation of a germ , and then, by sampling the principal flow, the growth obtained from the germ.

This method was developed in connection with the physical transport of HgI_2 (mercuric iodide), with excellent results in the laboratory.

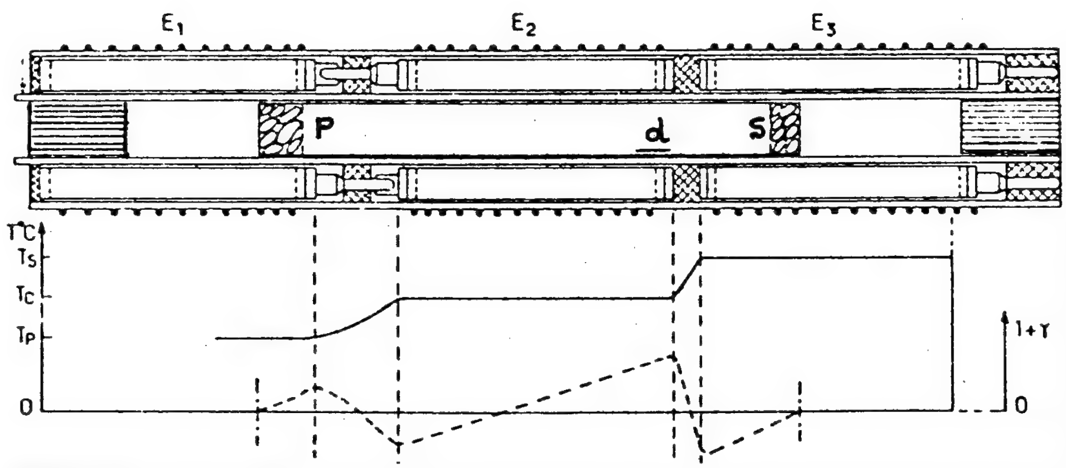


Fig IV-1 - A 3-isothermal-zone furnace: Temperature and concentration as a function of equilibrium.

Minizone Project

This instrumentation project is associated with the activities of the CNRS's Magnetism Laboratory at Grenoble, but it is a general-purpose device for floating-zone fusion.

A furnace of this type will enable the study of magnetic structures of the rare-earths and transition metals type obtained by resolidification from a melted zone that does not have contact with a crucible wall, which is essential for materials that are chemically very active at high temperatures.

It uses samples of small diameter, making it possible to set up the floating zone in the terrestrial environment for all types of compounds in general.

Its principal characteristics are:

--Heating by three standard homogeneous lamps placed at 120°C [as published]; maximum power 450 watts thermal;

--Diameter of sample 3 to 5 mml length 60 mm. Encapsulation in quartz tube for vacuum or pressure environment around the sample;

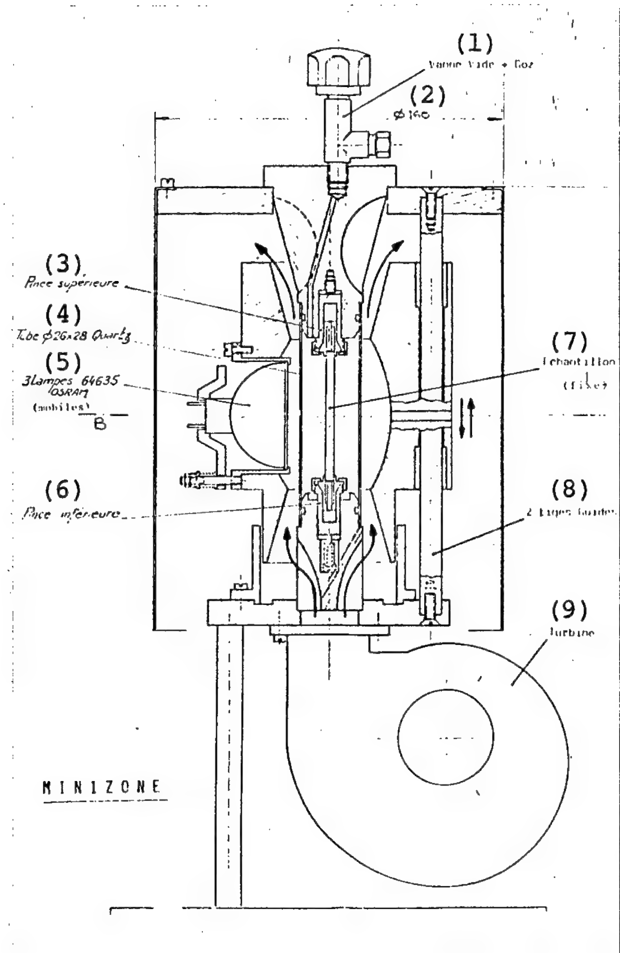
--Shuttle run ±15 mm, by displacement of heating system, no rotation;

--Maximum temperature 1,500°C (according to materials);

--Control by pre-programmed power, after tests and calibration;

--Forced cooling by ambient air;

--Optical monitoring of melted zone.



Minizone furnace.

Key:

1. Vacuum and gas valve.
2. Diameter 160 mm.
3. Upper clamp.
4. Quartz tube: Diameter 26 mm, length 28 mm.
5. Three Osram 64635 lamps (mobile).
6. Lower clamp.
7. Sample (fixed).
8. Guide pins.
9. Turbine.

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BRIEFS

FRG STEEL INDUSTRY RESTRUCTURING--Essen, 20 July (AFP)--The president of the Krupp industrial group (iron and steel plants, naval construction, machines), Wilhelm Scheider, said Wednesday in a press conference that the reorganization plan for the West German iron and steel industry prepared by the three "moderators" was "remarkable." This plan, it was pointed out, called for the creation of two big groups: the "Rhin" group, formed after the merger of the Krupp and Thyssen steel sectors, and the "Ruhr" group, consisting of Hoesch, Peine-Salzgitter and Kloeckner. This last company, however, in March, had abandoned the idea of the merger and decided to "go it alone," the negotiations with its two partners proving too difficult. What is going on in the European framework no longer has anything to do with the market economy, he added, deploring the lack of a sense of reality shown by the politicians, in the steel sector. "Normally, the market gives companies the criteria for decision. For the steel market, it is the civil servants who, in Europe, determine the production quantities, the prices, and the subsidies," continued Scheider. He once again indicated that he expects "positive results" from the negotiations on the merger of the steel activities of Krupp and Thussen, but he refused to set an exact date for these results. [Text] [Paris AUTO-INDUSTRIES in French 21 Jul 83 p 12] 12368

CSO: 3698/389

FRG RESEARCH MINISTER WANTS REORIENTATION OF POLICY

Duesseldorf VDI NACHRICHTEN in German 22 Jul 83 p 1

/Unattributed article/

/Text/ The Federal Minister for Research and Technology, Dr. Heinz Riesenhuber, in an interview with VDI-Nachrichten thinks that the reorientation of research policy can show tangible successes (see Page 5). Thus, for example, the proportion of indirect research funding has risen by about 45 percent, and the Federal Finance Minister who is again allowing special depreciation for research expenditures.

In a conversation with VDI-Nachrichten, the Federal Research Minister, Dr. Heinz Riesenhuber, emphasized that, at the present time, the character of the Federal Ministry for Research and Technology (BMFT) is changing. The Ministry, according to the Minister, must abandon the management of many individual research projects and must address tasks which up to now have not been regarded sufficiently, such as the "cross-section tasks" of climatic research, environmental research, and health research. The BMFT also would have to ask itself more pointedly what powerful infrastructures the government could build up for research. In this connection, Riesenhuber mentions federal information networks, which facilitate decentralized access to decentralized information and which might be especially useful for medium businesses.

Long-term research projects and tasks with a higher development risk continue to be typical cases for direct research funding, according to Riesenhuber. The disadvantage of project funding would lie in the fact that a testing phase precedes the beginning of the project, which could lead to time delays. Especially small and medium projects, which are introduced into dynamic markets, are therefore deemed unsuitable for this type of funding. This is supposed to hold especially for the areas of production technology, robot technology, CAD-CAM technology, and microelectronics, in which direct research funding would furthermore predominantly favor foreign vendors and would cultivate competition. Here, Riesenhuber would like to apply so-called indirect specific programs.

For the Federal Research Minister, the point is first of all to pose the "correct questions", so as to find "correct answers", especially in the rising areas of biotechnology and data processing. In this connection, Riesenhuber regrets that

the development of a fifth generation computer, that is a machine which recognizes language and communicates in human terms has been largely left to the USA and Japan. But he sees certain chances to participate in this project, if several European countries pool their resources sensibly, as is being done in the "Esprit" project.

So that research areas and technologies which may become important over the long term can be recognized at an early date, forecasting instruments have been set up in the major research institutions. To reduce deficits, for example, in biotechnology and gene technology, Riesenhuber deems the German research establishment as sufficiently equipped; he does not intend to create new major research institutions. In general, his research policy during the next few years should "create spaces for new techniques to become innovations."

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SIEMENS WARNS GOVERNMENT AGAINST NEGLECTING DIRECT R&D AID

Duesseldorf HANDELSBLATT in German 27 Jul 83 p 4

/Unattributed article/

/Text/ Industrial circles have warned the Federal Research Minister Heinz Riesenhuber against neglecting direct project funding in favor of indirect funding.

In the 1984 budget, the means for direct funding have been lowered by 0.6 percent, and those for indirect funding have been raised by 45.9 percent. Minister Riesenhuber in this connection spoke about the "changed switch position" of the new government.

The warning to Riesenhuber was formulated by the member of the Board of Siemens AG, Karl Heinz Beckurts, in a letter. "If, in the past, direct project funding was frequently overemphasized, a dangerous trend is now perceptible, to set back this important means of research policy," so Beckurts writes to the Minister, and speaks of a "sometimes" too one-sided consideration of things.

During the social-liberal government, the CDU/CSU opposition of that time blamed Bonn about pursuing too one-sided a preference for direct project funding. Siemens is one of the largest receivers of direct funding monies.

The Board Member Beckurts, in his letter, designates a well-balanced consideration of multiple funding instruments as a component of an innovative research policy. To his letter he adds an eight-page appendix, in which he transmits "some of our considerations on this group of topics." The Federal Research Ministry has confirmed receipt of this letter, upon inquiry of the Handelsblatt. The Ministry will comment only after a "careful examination."

The paper by Siemens AG points out that the instrument of direct project funding "very successfully and in a goal-directed fashion funded peak technologies such as microelectronics, information technology, and the peaceful use of nuclear energy, from which a large number of innovations was spun off." The present multiplicity of topics would obfuscate the view of the facts. The conclusion is: The broad spectrum would again have to be brought back "to a few absolutely important funding emphases."

The Siemens paper makes reference to the stringent requirements which direct research funding imposes on enterprises, such as "the disclosure of the R&D program, often also including the entire business policy and the strategic planning in this area." By contrast, it is characteristic for indirect research funding by personnel cost supplements that it represents "funding without requirements."

Furthermore, it then goes on to say that indirect research funding is similar, "rather to a technological migration of peoples which primarily serves the health of the participants and offers little stimulus for sporting peak performance. Great basic innovations, without which industry cannot persist in international competition, are not generally initiated in this way."

Microelectronics, and here especially the technology for producing very highly integrated components, are called a basic technology of high significance in this study. "Due to direct project funding, this technology is firmly anchored in purely German businesses and is consequently available in this country free of political risks." The direct project funding by the Federal Ministry for Research and Technology would in many cases lead to fruitful cooperation in research and development between the participating enterprises as well as with colleges and other state research institutions. The paper points out the special significance of electronics "for all other branches." Microelectronics is supposed to be the "lance's tip of this technology." Without it, the "factory of the future" is not imaginable, likewise not the "office of the future."

The Siemens study finally suggests the requirement that project funding be concentrated "on a few highly innovative areas" such as microelectronics and information technology as well as special topics of future energy supply or medical technology.

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SOVIET CHEMICAL LICENSES TO WESTERN FIRMS

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 22 Aug 83 p 2

[Text] Moscow, 21 August--The assignment of chemical licenses by the Soviet Foreign Trade Organization Lizensintorg (special firm: Lizenschim) to foreign licensees increased by a factor of 2.5 during the period from 1980 to 1982, in terms of business volume, according to Soviet data. The group of foreign licensees has been especially broadened by Western firms. Lizenschim appears on the foreign markets as licenser, and plays the role of licensee in the areas of chemical, petroleum, microbiological, pharmaceutical, and medical-technological industries.

The Austrian firm Simmering Graz Pauker procured a Soviet license for the manufacture of technical resins based on phenol. The Swedish enterprise Eka procured a Soviet license to produce peroxide chemicals. The Japanese firm Nagoya Oil and the Finnish firm Priha procured licenses for the manufacture of synthetic glues, and the French enterprise de Dietrich procured a license to construct rotational evaporators. The Brazilian firm Coalbra purchased a Soviet Know-How license for wood hydrolysis to produce ethyl alcohol as a motor vehicle fuel. With the participation of Lizenschim, an agreement was reached with the Italian firm Snam-Projetti concerning coproduction of catalysts for isobutylene manufacture and the joint construction of a power plant for test purposes.

The licensing business of Lizenschim recently has also extended to environmental protection. Thus, the Finnish firm Kemira procured a Soviet license for the catalytic cleaning of exhaust gas during the production of nitric acid. Another business focal point consists of medical equipment and instrumentation. The US-American enterprise Surgical Corp. purchased a license to produce surgical instruments.

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NEW VW AUTOMATED ASSEMBLY SHOP 'MOST MODERN' IN WORLD

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 24 Aug 83 p 30

[Article by Joh. Chr. Spira]

[Text] Simultaneously with the successor to the Rabbit, VW is presenting the most modern automobile assembly shop in the world. In the construction of car bodies, automated production for a long time has been the state of the art, but a high degree of automation is new for automobile assembly. The experts confirm: up to now, there never has been anything comparable, not even in Japan. The system arose with the objective of assuring competitiveness in Germany as a high-wage country. The point here was not only to increase the productivity but also the quality level of the Rabbit. This conceals a long-term planning philosophy. On the one hand, modern and abundantly equipped vehicles represent an increasing expenditure of labor; on the other hand, there is a necessity to increase production. In view of the challenges for competitiveness, there evidently is no alternative, especially since a fall of product quality is just as indiscutable as the loss of social ownership.

Increased mechanization implies the development of high-grade regulation technology for detecting defects on time. An especially important feature with the new automatic VW assembly plant consequently was the task of installing numerous small control circuits. The integration of such test sequences in the assembly belt area - they are decoupled from the time pressure of the assembly belt - is equally significant for quality and for the humanization of the work. Its advantage: they allow a nearly perfect early defect diagnosis and thus prevent defective products from being built into the vehicle in the first place. Thus, the often difficult follow-up removal of defective parts is obviated. Reduced follow-up work implies a quality gain and simultaneously the elimination of unpleasant working steps. Furthermore: Although the new belt runs faster, there is practically no hectic atmosphere anymore.

The new mysterious production shop is called Hall 54. It is connected with previous production by a tunnel system. For secrecy reasons, no visitors will be allowed here until the middle of 1984. With 53,000 square meters, it belongs among the largest assembly halls in the world. Two stories contain 120,000 square meters of useful area, including ramps. A fully automated assembly of the units and parts into modules takes place in the ground story. The upper story contains a fully automated body assembly shop, which has been implemented for the first time in this form.

Things begin in the ground story, where the actual drive train is produced: The engine support, the auxiliary frame, the engine, and transmission, steering, and shock absorbers, battery, front end, and rear axle. Somewhat further down is the path for the shock absorber mounts by the front axle. These come from Hall 13, where they too have already been assembled automatically. The journey of the basic transmission is still longer. It is delivered from another plant. Here, it is now complemented with drivers, consoles, and all those parts which are so bulky that they cannot be transported to Wolfsburg without a problem. In extremely precise assembly steps, these modules are turned into the complete transmission on two mighty turntables with a high complement of machinery.

The production lanes for the basic engine are no less impressive because of their mechanization complement. There are two, running in a square, while robot grippers constantly add to the basic engine. In fact, this is no everyday scene, how the starter, the generator, the consoles for the fastening supports, and other parts are assembled without human intervention. Robots even install the V-belt and tension it according to prescription. At any rate, 100 to 150 different engine variants are created in this way, controlled by a complicated computer connection. Auxiliary frames and engine supports complete the drive train. To this are added the steering and shock absorbers with control arms. Computer control also takes care that the rear axle, which has already been mounted automatically elsewhere, arrives in place at the right time through its own conveyor paths.

Among the automatically premounted systems belong even the front section with the radiator grill, headlights, horn, and other parts. All units therefore have already been produced in the ground story and are connected together as a construction set and thus are conveyed into the upper story. Their solid connection with the already completed body takes place there automatically.

For mechanization, all of this implies a total of 300 automatic screw operations. To this are added two to three joining processes per screw operation. This results in an imposing multiplicity of automatic functions, which must be matched to one another with split second accuracy. But there still also exists purely manual production steps. Among these belong the joining of the cooling hoses and the laying of cables. The installation of the radiator on the propulsion system and the adjustment of the circuitry is also reserved for workers. On five assembly lines in the upper story of Hall 54, the Rabbit body is equipped with the necessary units. Subsequently, an elevator takes them over and transports them downward to the two major lanes where final assembly takes place.

Again and again, there are automatic checks. Are all the fastening pins present? Are these pins at the right place? And are they not bent? And is it indeed the right type? Automatic gauges rise, scan everything, and then report "okay". Especially interesting is the automatic installation of the fuel line. This flexible structure is not simply installed only from below. The line must be pushed into a tunnel within the body and must be clamped in. This is also done automatically. No less complicated is the installation of the battery by robots. Even the clamps for fastening the battery are automatically inserted and screwed together. The automatic assembly of the complete brakeline system also offers advantages. Disturbances through contamination no longer occur. The complete fuel container migrates, in completely pre-assembled fashion, directly into the line for installation. By means of strap retainers, robots then directly assemble it into the body.

It is no different with the exhaust system. Even before it is assembled, heat shields must be placed as insulation to the passenger compartment. While the equipment is running in the exhaust system, it simultaneously leads the two ends together, pushes a sleeve over it, and screws everything together with the engine. Naturally, the exhaust line is also suspended automatically at the hooks of the body by means of rubber rings. The rear axle is screwed together with the body automatically also. Further down the lane system, the completely assembled front end is installed. The wheels are fed in and assembled also with target control according to programmed customer wishes. Whether it be four wheels and a minispare or the standard five wheel set. Here, the system automatically sorts according to tire manufacturers and rim designs. Even the placement of the spare wheels is taken care of accurately by the robots.

A system of this magnitude represents not only the most stringent requirements on the planning and development of the numerous automation devices with computers and control systems. The vehicle designers also had unprecedented demands placed on them. Numerous components, down to the complete engine, had to be designed appropriate for assembly in all details. But everything that is optimized for full mechanization must also be suitable for manual assembly. It must be possible to manufacture the Rabbit anywhere in the world, even in small halls and in smaller numbers of units. About 135 specialists are the maintenance personnel who service the new fully mechanized VW assembly plant. These are highly qualified employees, whose intensive training makes them capable of diagnosing disturbances in the mechanics and electronics and of eliminating them as quickly as possible.

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